International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 8, Issue 2, Apr 2018, 1049-1058

SCHEDULING AND OPTIMISATION USING IN FLEXIBLE MANUFACTRUING SYSTEM USING PETRINET TO INCREASE UTILISATION OF RESOURSE SYSTEM

KIRUBAGHARAN. R & NAVEENRAJ. A

Department of Mechanical Engineering, M. Kumarasamy college of Engineering, Karur, India

ABSTRACT

Adaptable Manufacturing System (FMS) is an automated gathering structure which has the work shop flexibility and stream shop efficiency. One of the genuine stresses in FMS is reserving of occupations to the machines with the objective of extending machine utilize. A Petri net is a graphical logical showing instrument proper to various systems and this is a promising gadget for depicting and thinking about information taking care of structures that are portrayed as being synchronous, non- simultaneous scattered, parallel, nondeterministic and stochastic. The Petrinet thought is proposed to deal with booking issues. Scatter Search figuring is masses based met heuristic that used to join its answers and grow new game plans. This strategy makes a masses of courses of action. The dispatching rules estimation has accepted a vital part in the passage of occupation to the machine according to the need of given decided parameter. Dispatching Rules look like Shortest Processing Time (SPT), Longest Processing Time (LPT), Least Operation Remaining (LOR), Most Work Remaining (MWR), Most Operation Remaining (MOR) and Least Work Remaining (LWR). This paper oversees exhibiting and booking of Flexible Manufacturing System (FMS) using various Meta Heuristics computations like Petrinet, Dispatching Rules and Scatter Search. The results are considered for three particular relevant examinations and it is watched that the Petrinet gives a better result when differentiated and diverse figurings, for instance, Dispatching Rules and Scatter Search estimation concerning machine use.

KEYWORDS: Flexible Manufacturing System, Petrinet, Scatter Search Algorithm & Machine Standardisation

Received: Feb 21, 2018; **Accepted:** Mar 04, 2018; **Published:** Mar 21, 2018; **Paper Id.:** IJMPERDAPR2018121

Original Article

INTRODUCTION

Petrinet was named after Carl A. Petri, who made a net-like logical gadget for the examination of correspondence with automata in 1962. They were additionally made to address the issue in deciding procedure synchronization, unique event, synchronous tasks, and conflicts or resource sharing for a variety of mechanical electronic structures at the discrete-events level.

In any physical net, we can find two basic parts are center points and associations. The two center points and associations accept their own particular parts. For example, qualities could be traded beginning with one end then, onto the following through center points and associations. Different centers and associations may bear unmistakable qualities. A Petrinet isolates centers in two sorts: places and moves.

Moves address the events or tasks. They are imagined by cleansing rectangles or solid bars. Two essential events are "start" and "end". As opposed to bidirectional associations in some physical nets, a PN utilizes guided round sections to relate from spots (called input puts with respect to a move) to moves or from moves to places

(called yield places). So to speak, the information trade from a place to a move or from a move to a place is one-way. Two courses Transfer between a place and move is refined by delineating a roundabout section from a move to a place and another curve from the move back to the place.

Places, moves, and facilitated twists make a PN a planned outline called the Petrinet structure. The components are familiar by allowing a place withhold it is conceivable that one or a positive number of tokens envisioned by minimal solid spots. These bits could address the number of advantages or show whether a condition is substantial or not in a place. Right when all data places hold enough number of tokens, an event exhibited by a move can happen called move ending. This ending changes the token transport in spots, inferring a change of structure states of tokens and their stream controlled through moves permit one to picture the material, control and data stream unmistakably. Besides, one can play out a formal check of the properties identified with the fundamental frameworks conduct, e.g., priority relations among occasions, simultaneous operations, fitting synchronization and opportunity from halts, monotonous exercises, and the common rejection of shared assets.

LITERATURE REVIEW

Petrinets are logical formalism intended to be used for illustrating, reenactment and examination of different kinds of structures (1). In programming building, Petri nets are used for exhibiting a wonderful number of either hardware and programming structures or distinctive applications in PC frameworks. An excellent good position of Petrinet is their graphical documentation, which diminishes Petrinet learning time and unravels their use (2). Consequently, Petrinets are used for educating different thoughts in programming building (3). The trail systems in programming designing have a great part of the time incite to basic upgrades in both theory and practice. Creating models and performing entertainment are the inside issues in test strategy (4). A Petrinet can be recognized as a particular kind of bipartite composed diagram populated by three sorts of things. These things are places, moves and guided curves partner spots to moves and moves to places.

The focal piece of the Petrinet structure is a Petri net comprises of the Petri net essential ideas: places, moves, and bend (5).

Hung et al. (6) show a Petri net way to deal with displaying and recreation of a dispersion cell controller in an IC CIM System. Numerous semiconductor manufacture procedures are extremely mind- boggling and managing deterministic circumstances at the procedure step level and vulnerability at a larger amount because of asset conflict, expected upkeep downtime and sudden disappointments. Consequently, diagnostic arrangements get to be distinctly inconceivable for these cases.

Xiong (7) proposed the usage of Petri nets and heuristic request estimations to timetable semiconductor test office. Two mutt frameworks are used and contemplated. The greatest system contains a number of advantages with their sums fluctuating from one to fourteen, 30 occupations each with three test handle steps.

Cavalieri et al. (8) researched the utilization of shaded Petri nets as a structure to plan adaptable semiconductor fabricating frameworks in a genuine modern plant. A heuristic calculation is proposed to infer dispatching rules for each machine.

Silva et al. (9) Petri nets have been given off an impression of being productive instruments for showing FMS because of the great conditions, for instance, the graphical nature, the compactness of typifying both the static structure and the stream, and the openness of the numerical examination techniques. In any case, when the exhibiting of an FMS is driven without any controls, separating the resultant net for such subjective properties as liveness is dreary and computationally absurd. To make the above issue tractable, diminishment and mix techniques are routinely utilized.Agerwala et al. (10) proposed a blending technique which builds nets by combining subnets through sharing regular spots. Combination strategies can be characterized as orderly systems of developing net models. Past work on Petri net blend for assembling displaying concentrated on ensuring properties without performing back examination.

METHODOLOGY

The FMS is expected for its flexibility and it has four traits, for instance, the passage of occupations, process time on machines, arranging precepts and requirement for organizations. The issue which we have to handle here is an occupation shop booking issue in FMS. The business shop includes different getting ready concentrations called machines, which are fit for playing out various sorts of activities. A business is an asked for a course of action of activities and the asking for is given in need relationship. An area or not entirely finished thing which enters and moves inside an FMS is known as a segment. A finished part that leaves the FMS is known as a thing. Each thing is the result of a progression of techniques as demonstrated by its creative requirements. Resource necessities are not considered in the methods. A progression of methods portrays a thing sort or an occupation sort. The arrival of occupations are moved depends on upon the method in light of the way that different jobs and unmistakable activities, so the machine gathering of the thing will be changed. There are three relevant examinations using making arrangements for different occupations and unmistakable tasks like (9 machines X 2 businesses, 14 machines X 3 occupations and 6 machines X 6 occupations). The three logical examinations contemplated for metaheuristics counts Petrinet thought is the most better result and perfect machine use. Using the Petrinet contraption MATLAB and viewed the perfect showing result. Here, the Petrinet is proposed to deal with arranging issues and differentiated and Dispatching Standards and Diffuse Inquiry Calculation in term of machine utilization. take a gander at the numerous logical investigations dealing with the arranging issues using metaheuristics figurings the Petrinet thought is the best machine utilize when standing out from other Dispatching Guidelines and Disperse Pursuit Calculations.

PARTS OF THE PETRINET

- Places are Denotes to a circle.
- Transition Denotes to a bar.
- Directed arc represents to connect the place to transition.
- Black dots are called as a token.

The components are used in Petrinet modeling and the diagram is shown in Figure. 1.

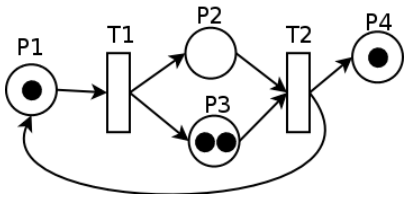

Figure 1: Layout of Petrinet

Figure 1 shows the basic functioning of Petrinet. The current position (P_1) having one token and it is ready to fire from its place and move to the place (P_2) with help of transition (t_1).

In the event, that and have no consecutive affiliation or they are free without place and the related circuitous parts, the structure is a parallel fundamental rejection. The focal points can be asked for into submitted and shared ones. The devoted part in a place with single information and single yield round sections just, the mutual ones a place with different information and various yield twists. A condition tending to the status of a sensor or an actuator is beside appeared with a place whose holding a token proposes reality of the showed condition. A relative sort of advantages might be tended to by a place with the measure of tokens diverging from the measure of preferences. Start of an operation requires as frequently as conceivable two or three sorts of conditions and assets accessible appeared as a move to several information places. A finish of an operation may discharge two or three preferences and change the status of the conditions appeared as a move with a coupling yield

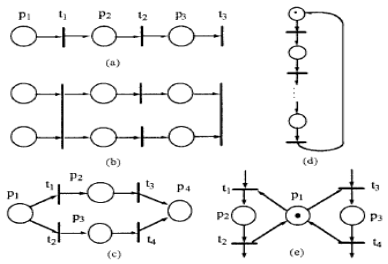

Figure 2: Examples of Basic Relations (a) Sequential, (b) Concurrent, (c) Conflicting, (d) Cyclic, and (e) Mutually exclusive

DISPATCHING RULE

Booking is a fundamental initiative process and it concerns the conveyance of the compelled resources for assignments after some time and is a basic part of creation systems since it fills in as a general game plan on which various other shop activities are based. By fittingly masterminding and timing of shop floor works out, various system execution measures can be streamlined.

Dispatching guidelines are among the practically sometimes associated with progress arranging, due to their straightforwardness of execution and low time multifaceted nature. At whatever point a machine is open, a dispatching standard explores the holding up vocations and picks the occupation with the most hoisted should be taken care of next.

CASE STUDY

In this paper, the 9 machine X 2 product (case study-I), 14 machine x 3 product (case study-II) and 6 machine X 6 product (case study-III) are taken for the analysis and compared with Petrinet, scatter search and dispatching rule.

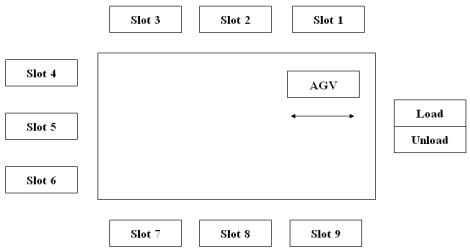

Table 1: Configuration of FMS for Case Study-I

Layout Type	No. of Machines	No. of Parts	Load/ Unload Stations	No. of AGV
U Loop	09	02	02	01

Table 2: Operation Sequence for Case Study-I

Part Type	Operation Sequence								
	1	2	3	4	5	6	7	8	9
P1	M2	M5	M3	M1	M8	M4	M6	M9	M7
P2	M6	M9	M5	M3	M1	M4	M7	M8	M2

Table 3: Operation Time for Case Study-I

Part Type	Operation Time								
	M1	M2	M3	M4	M5	M6	M7	M8	M9
P1	62	9	89	87	10	66	95	49	82
P2	30	95	58	61	58	60	17	8	5

Case Study-II

The Table 4 shows the operation sequence for a different product (P- Knuckle, T_{200} –Knuckle, Brake Disc) indicated in the table. And the operation time is shown in Table 5 for different products indicated above.

Let there be three parts to be processed on fourteen different machines. The Table 4 indicating the operation sequence number of three different parts. The operation time shown in Table 5 and Table 6 shows the machine name.

Table 4: Operation Sequence for Case Study-II

Product Name	Operation Sequence						
P- Knuckle	1	2	6	7	8	9	11
T_{200} -Knuckle	3	11	10	9	8	13	12
Brake Disc	4	5	13	14	-	-	-

Table 5: Operation Time for Case Study-II

Part Name	Operation Time						
T_{200} Knuckle	M3	M8	M9	M10	M11	M12	M13
	220	22	104	210	142	143	29
P- Knuckle	M1	M2	M6	M7	M8	M9	M11

Table 6: Machine Types for Case Study-II

Machine Name	SPM	CNC Lathe	VMC Drilling	VMC Milling	KPA Milling	Grinding
Machine No	1	2,3,4,5	6,8,10,12	7,9,13	11	14

RESULTS AND DISCUSSIONS

Keeping in mind the end goal to test the adequacy and execution of the proposed Petri net, Scatter Search and dispatching rules. By breaking down working on this issue investigation of 9 machine X 2 job,14 machine X 3 occupation and 9 machines X 2 item. The outcome is given for the comparing contextual analysis and their required parameter.

The results of each case study by using petrinet modeling are given below.

Results for Case Study-I

Table 7 shows the machine number and their machine utilization in terms of percentage by using petrinet modeling.

Table 7: Machine Utilization for Case Study-I in Petrinet Modeling

Machine N0	M1	M2	M3	M4	M5	M6	M7	M8	M9
PETRINET	80.12	70.23	93.59	59.66	92.75	95.06	49.77	46.57	84.23

Table 8: Machine Utilization for Case Study-III in Petrinet Modeling

Machine N0	M1	M2	M3	M4	M5	M6
PETRINET	70.6	73.2	64.9	61.82	93	90

Figure 1 shows the machine number in X-axis and Y-axis machine utilization as mentioned in the above table

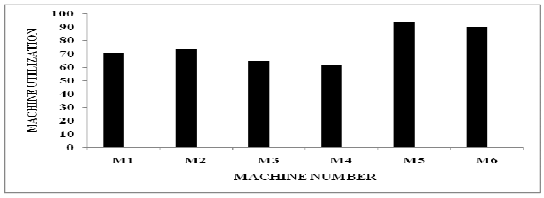

Figure 1: Performance of Petrinet for the Case Study-III

The results of each case study by using Scatter Search are given below.

Results for Case Study-I

Table 9 shows the machine number and their machine utilization in terms of percentage by using Scatter Search.

Table 9: Machine Utilization for Case Study-III in Scatter Search

Machine No	M1	M2	M3	M4	M5	M6	M7	M8	M9
Scatter Search	52.60	57.20	85.90	67	64.40	75.60	39.70	40	43.50

Figure 2 shows the machine number in X-axis and Y-axis machine utilization as mentioned in the above table

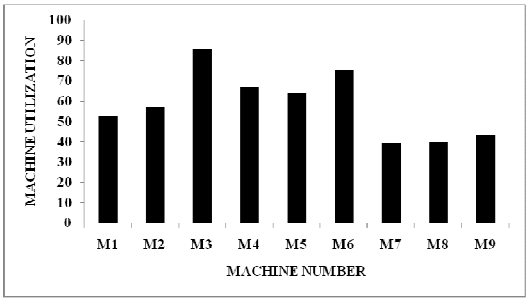

Figure 2: Performance of Scatter Search for the Case Study-I

Result for Case Study-II

Table 10 shows the machine number and their machine utilization in terms of percentage by using Scatter Search.

Table 10: Machine Utilization for Case Study-III in Scatter Search

Machines	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
%	13.50	43.80	66.00	69.00	46.00	19.20	16.00	16.20	13.50	21.00	42.30	14.30	8.90	2.50

Figure 3 shows the machine number in X-axis and Y-axis machine utilization as mentioned in the above table

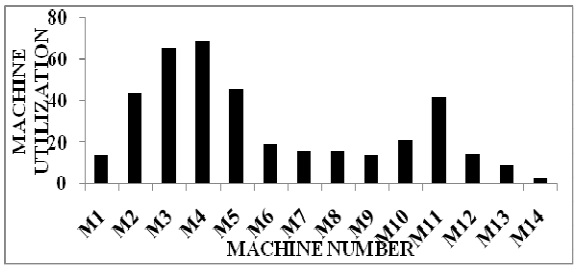

Figure 3: Performance of Scatter Search for the Case Study-II

Result for Case Study-III

Table 11 shows the machine number and their machine utilization in terms of percentage by using Scatter Search.

Table 11: Machine Utilization for Case Study-III in Scatter Search

Machines	M1	M2	M3	M4	M5	M6
%	46.30	32.60	63.20	61.80	58.80	27.10

Figure 4 shows the machine number in X-axis and Y-axis machine utilization as mentioned in the above table

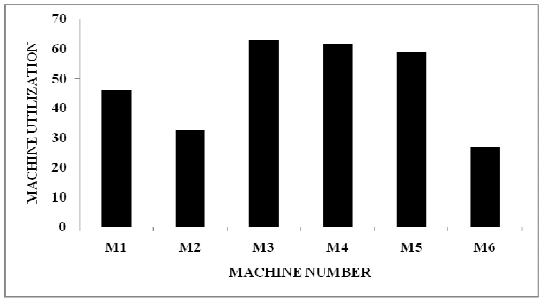

Figure 4: Performance of Scatter Search for the Case Study-III

The results of each case study by using dispatching rules are given below.

Result for Case Study-I

Table 12 shows the machine number and their machine utilization in terms of percentage by using dispatching rules.

Table 12: Machine Utilization for Case Study-I in different Dispatching Rules

	M1	M2	M3	M4	M5	M6	M7	M8	M9
SPT	55.5	60.5	91.3	70.5	68.4	90.3	29.6	35.9	34.9
LPT	60.5	49.5	93.9	72.4	84.2	91.1	28.5	44.1	33.6
LOR	51.7	55.1	90.6	71	73.7	87	36.3	22.3	30.1
MWR	54.5	61.2	93.7	54.9	74.6	92.2	19	34.3	21.5

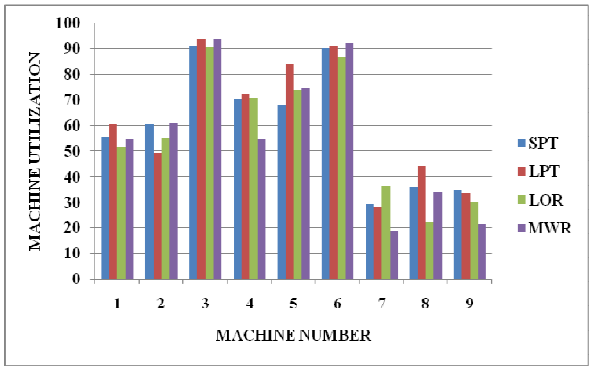

Figure 5: Performance of Dispatching Rule for the Case Study-I

Figure 12 shows the performance of different dispatching rules keeping X-axis as machine number and Y-axis as machine utilization

Result for Case Study-II

Table 13 shows the machine number and their machine utilization in terms of percentage by using dispatching rules.

Table 13: Machine Utilization for Case Study-II in different Dispatching Rules

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
SPT	49.8	93.2	96.6	97.4	74.8	63.6	41	30.9	24.8	59.8	57	14.3	20.9	5
LPT	49.8	93.6	96.6	97.4	74.6	63.4	41	30.9	24.8	59.8	57	14.3	20.9	5
LOR	49.8	93.2	96.6	97.4	75	63.4	41	30.9	24.8	59.8	57	14.3	20.9	5
MWR	49.8	93.6	96.6	97.4	74.6	63.4	41	30.9	24.8	59.8	57	14.3	20.9	5

CONCLUSIONS

This paper includes on the MATLAB petrinet, Scatter Search calculation and dispatching rules. To concentrate the execution of the given FMS, the Petrinet indicates ideal machine usage than Scatter Search result and determined dispatching rules from the watched three contextual analyses. In future work, the MATLAB petrinet approaches have various particular ramifications for the objective of planning enhanced streamlining techniques. To comprehend these suggestions, it is valuable to consider the certain complexities exceptionally exploitable importance of "arrangement blend" and assessing the MATLAB petrinet with various demonstrating and to give an examination between them.

REFERENCES

1. *Peterson, J. L. (1981), "Petri net theory and the modeling of systems", New Jersey, Prentice Hall, Englewood Cliffs.*
2. *Denning, P. J. (2000), "Computing the profession". In Greening, T. (Ed.) Computer Science Education in the 21st Century, New York: Springer-Verlag, 27-46.*
3. *Jeffrey, J. M. (1991), "Using Petri nets to introduce operating system concepts". In Dale, N. (Ed.) Paper presented at the SIGCSE Technical Symposium on Computer Science Education, 7-8 March, San Antonio, USA.*
4. *Desel, J. (2000), "Teaching system modeling, simulation and validation". Paper presented at the 32nd Conference on winter simulation, 10-13 December, Orlando, FL, USA.*
5. *Murata, T. (1989), "Petri nets: Properties, analysis and applications". Proceeding of the IEEE. Vol. 77, No. 4, 541-580.*

6. *Feng., W.-C. Hung (1997), Modeling and simulation of a Petri nets based diffusion cell controller in an IC CIM system," in Proc. 1997 IEEE International Conference Systems, Cybernetics, Orlando, FL, Oct. 12–15, 1180–1185.*

7. *Xiong, H. H. (1996), "Scheduling and discrete event control of flexible manufacturing systems based on Petri nets", Ph.D. dissertation, New Jersey Institute of Technology, Newark.*

8. *Cavalieril, S., Mirabella, O., Marroccia, S. (1997), "Improving flexible semiconductor manufacturing system performance by a colored Petri net-based scheduling algorithm," in Proc. 6th IEEE International Conference in Emerging Technologies and Factory Automation, Los Angeles, CA, Sept. 9–12, 369–374.*

9. *Silva, M., Valette, R. (1987), "Petri nets and flexible manufacturing", LNCS: Advances in Petri Nets, 374–417.*

10. *Agerwala, T., and Choed-Amphai, Y. (1978), "A synthesis rule for concurrent systems," in Proc. 15th Design Automat. Conf., Las Vegas, NV, June, 305–311*